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# Digestibility and dry matter intake of diets containing alfalfa and kenaf<sup>1,2</sup>

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**ABSTRACT:** Two experiments were conducted to determine the dietary value of pellets containing kenaf (*Hibiscus cannabinus* cv. 'Everglade 41') hay. Averaged across both experiments, kenaf pellets contained 82.6% kenaf hay, 16.6% liquid molasses, and 0.8% mineral oil. The chemical composition of the kenaf pellet was 12.6% crude protein (CP), 41.2% neutral detergent fiber (NDF), and 14.4% acid detergent fiber (ADF). In Exp. 1 (digestion and N balance trial), 18 lambs (body weight [BW] = 36.4 kg) were blocked by BW. Lambs were randomly assigned within a block to Diet 1 (59.5% corn and 40.5% alfalfa pellet), Diet 2 (59.7% corn, 28.4% alfalfa pellets, and 11.9% kenaf pellets), or Diet 3 (59.6% corn, 16.5% alfalfa pellets, and 23.9% kenaf pellets). Diets were formulated so that CP was the first-limiting nutrient. Each diet was limit-fed at 2.4% of BW. Replacing alfalfa pellets with kenaf pellets tended to decrease ( $P = 0.10$ ) CP and ADF intakes, but increased ( $P = 0.01$ ) DM digestibility. Diet had no effect

( $P = 0.33$ ) on N balance. In Exp. 2 (dry matter [DM] intake trial), 32 lambs (BW = 30.4 kg) were blocked by gender and BW. Within a block, lambs were randomly assigned to one of four diets in a  $2 \times 2$  factorial arrangement. Main effects were hay (bermudagrass or fescue) and supplemental protein source (kenaf or alfalfa pellets). Lambs were housed in individual pens with ad libitum access to the assigned hay. Supplemental protein was fed (185 g of DM) once daily. Hay intake was measured weekly for 8 wk. Lambs consumed more ( $P = 0.002$ ) fescue than bermudagrass hay (743 vs 621 g/d). Lambs fed fescue hay gained weight more rapidly ( $P = 0.001$ ) than lambs fed bermudagrass hay (120 vs 72 g/d). Hay intake and ADG were similar ( $P = 0.90$ ) for lambs fed alfalfa or kenaf pellets. Kenaf hay mixed with molasses and mineral oil can be formed into a pellet. In the diets used in this experiments, kenaf pellets can replace alfalfa pellets in diets fed to lambs without altering forage intake, gain, or N retention.

Key Words: Digestibility, Hay, Intake, Kenaf, Lambs, Production

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## Introduction

Feeding small quantities of supplemental protein to steers grazing warm-season perennial grasses has been shown to increase ADG and forage intake (Galloway et al., 1993; Phillips and Horn, 1998). The supplement can be in the form of a liquid, block, or pellet, and it can contain as much as 65% nonprotein N (NPN) (Phillips and Horn, 1998). Although cool-season grasses usually contain more CP and are more digestible than warm-season grasses, supplementation with energy or protein can increase DMI (Phillips et al.,

1995). Instead of purchasing a protein supplement, producers may opt to use homegrown forages, such as alfalfa (*Medicago sativa*), to provide supplemental protein to grazing livestock (Hunt et al., 1987).

Kenaf is grown worldwide primarily as a renewable source of fiber. Mature plants are harvested for use in the fiber industry, but immature plants have been used as a high-quality feed for livestock (Phillips et al., 1996; Reuter et al., 1998; Phillips et al., 1999). The protein in immature kenaf has been shown to be more soluble than the protein found in alfalfa (Suriyajantrantong et al., 1973), which may alter ruminal DM digestion and DMI (Koster et al., 1996). The objective of these experiments was to determine the nutritive value of a CP supplement formulated with kenaf hay.

## Materials and Methods

### Exp. 1: Digestion and Nitrogen Balance Trial

Eighteen crossbred wether lambs (BW = 36.4 kg) less than 1-yr-old were used in a randomized complete-

<sup>1</sup>Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by USDA.

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**Table 1.** Ingredient and chemical composition (% of DM) of diets fed in digestion and N balance trial (Exp. 1)

Item	Diet		
	1	2	3
Ingredient <sup>a</sup>			
Corn	59.5	59.7	59.6
Alfalfa pellet	40.5	28.4	16.5
Kenaf pellet	0	11.9	23.9
Chemical composition <sup>b</sup>			
DM	90.99	90.76	90.53
CP	13.8	12.8	11.8
NDF	24.87	24.31	23.84
ADF	15.40	14.10	12.87

<sup>a</sup>Corn = cracked corn; alfalfa pellet = a commercial pellet; and kenaf pellet = 82.6% kenaf hay, 16.6% liquid molasses, and 0.8% mineral oil.

<sup>b</sup>Chemical composition calculated from the laboratory analysis of individual ingredients.

block design to determine the digestibility and N balance of diets containing different proportions of alfalfa and kenaf pellets. All procedures used were approved by the Institutional Animal Care and Use Committee. Lambs were randomly assigned to individual metabolism stalls designed to collect feces and urine separately and were blocked by BW. Within each block, lambs were randomly assigned to one of three dietary treatments (Table 1). Each diet was formulated to contain at least 11.8% CP, and was fed to provide 110% of the CP requirement for maintenance (NRC, 1985). The ration provided enough energy for an ADG of 100 g and enough CP for an ADG of 50 g. Each diet contained the same amount of cracked corn. Diet 1 contained only alfalfa pellets, whereas Diets 2 and 3 contained both alfalfa and kenaf pellets.

Alfalfa pellets were purchased from a commercial source. The kenaf pellets were manufactured at the USDA-ARS Grazinglands Research Laboratory feed mill (El Reno, OK). Kenaf hay was grown at the laboratory the previous season (1995) and harvested 58 d after planting using conventional hay harvesting methods. The hay was stored in large round bales in a covered structure until needed 10 mo later. In preparation for manufacturing the kenaf pellets, kenaf hay was ground in a tub grinder to reduce the particle size (<5 cm). The ground hay was ground again with a hammer mill. Kenaf hay (82.6%), liquid molasses (16.6%), and mineral oil (0.8%) were mixed and pelletized into a 9-mm diameter pellet. Pellets were cooled before being placed in paper sacks and stored for use in Exp. 1 and Exp. 2.

At 0800 each day, the diet assigned to each lamb (Table 1) was prepared by weighing each ingredient into a container, mixing the ingredients by hand, and transferring the mixture to the feeder. Any orts present in the feeders from the previous day were removed prior to feeding, weighed, dried at 60°C for 72 h,

weighed again to determine the DM content, and stored for later chemical analysis. Lambs had ad libitum access to water provided in an adjacent container. After a 14-d diet adaptation period, a 7-d fecal and urine collection period was initiated. Feces were collected daily, weighed, dried at 60°C for 72 h, weighed again to determine DM content, and stored. At the end of the collection period, all of the feces collected from each lamb was composited and a sample was taken for chemical analysis.

Urine was collected daily during the 7-d collection period in 9.4-L plastic containers containing 10 mL of 50% sulfuric acid. Each day the weight of the urine collected was determined, diluted to a constant weight, and a 100-mL sample was taken. Daily samples of urine were composited by lamb in 1,000-mL screw-capped plastic containers. Urine containers were kept refrigerated, and sulfuric acid (10 mL of 50%) was added to each container on d 1 of the collection period to maintain a low pH and prevent any N losses.

Samples of dietary ingredients were collected daily for seven consecutive days beginning 2 d before the initiation of the collection period. These samples were composited across the 7-d period, dried at 60°C for 72 h to determine DM content, and saved for later chemical analysis. Samples of orts, feed ingredients, and feces were ground to pass a 2-mm screen in a Wiley Mill (Arthur H. Thomas Co., Philadelphia, PA), and were analyzed for DM by drying at 100°C for 24 h. Nitrogen concentration of orts, dietary ingredients, and feces was determined by using a complete-combustion N analyzer (Leco CHN-1000, Leco Corp., St. Joseph, MO). Urine samples were digested in a block digester with sulfuric acid. Nitrogen concentration was then determined by auto analyzer. The NDF and ADF contents were determined by the method of Goering and Van Soest (1970).

Data were analyzed as a randomized complete-block design with the GLM procedure of SAS (SAS Inst. Inc., Cary, NC). In the statistical model, sources of variation were block, diet, and block × diet interaction. Lambs were used as the experimental unit and block × diet was used as the error term. If a variance ratio value of  $P < 0.01$  were observed in the statistical analysis, differences among means were determined using the least-significant-difference (LSD) option of the GLM procedure.

### Exp. 2: Dry Matter Intake and Growth Trial

Thirty-two spring-born crossbred lambs (BW = 30.4 kg) less than 1-yr-old were used in a randomized complete-block design to determine if kenaf pellets could replace alfalfa pellets in a forage-based diet for lambs. Lambs were blocked by gender (four wether and 28 ewes), and then BW. Lambs were randomly assigned within a block to one of four treatments in a 2 × 2 factorial arrangement. The main factors were hay sources (bermudagrass 'Midland' or endophyte-free

fescue 'Kentucky 31') and the supplement (alfalfa or kenaf). Lambs were randomly assigned to individual pens (1 × 3 m). Pens were located inside a barn, but were subject to changes in ambient temperature. The dirt surface in each pen was covered with wood shavings to absorb waste material and to keep lambs dry. Pens were equipped with two feeders, one for the assigned hay and one for the supplement. A container for water was placed in each pen away from the feeders containing hay or supplement.

Lambs had ad libitum access to either bermudagrass hay or fescue hay. Hay was purchased in large round bales and stored in a covered structure prior to being ground by a tub grinder to a particle length of 5 cm.

The alfalfa pellets were purchased from a commercial source. The kenaf pellets used in this experiment were from the same batch as those used in Exp. 1 (digestion trial and N balance). At 0900 each day, lambs received 185 g of DM as alfalfa or kenaf pellets in the feeder designated for the supplement. Hay was added daily to the other feeder to ensure that the lambs had ad libitum access to hay. Hay feeders were emptied weekly to determine the amount of hay consumed.

Samples of hay and supplement were taken daily and composited weekly, placed in a forced-air oven at 60°C for 72 h to determine DM content, and saved for later analysis. Dried samples of hay and supplement were grounded to pass a 2-mm screen in a Wiley Mill (Arthur H. Thomas Co.). Procedures used to determine N, NDF, and ADF content were the same as those used in Exp. 1.

Lambs were weighed on d 0, 28, and 56 of the experiment after 16 h without feed and water. On d 0, 29, and 57, blood samples were collected at 1400, approximately 6 h after the lambs received their daily allotment of supplement. Plasma was harvested and frozen for later analysis. Blood urea N concentration was determined by colorimetric procedure (Sigma #640-A, Sigma Chemical Co., St. Louis, MO).

Data were analyzed as a completely randomized block design by the GLM procedure of SAS. Hay consumption was analyzed within weekly periods, changes in BW were analyzed as two 28-d periods and as one 56-d period, and blood urea N concentration was analyzed within each of the three sampling dates. Lambs were used as the experimental unit. If a variance ratio value of  $P < 0.01$  were observed in the statistical analysis, differences among means were determined with the LSD option of the GLM procedure.

## Results and Discussion

### *Exp. 1: Digestion and Nitrogen Balance Trial*

Kenaf pellets were similar to alfalfa pellets in NDF concentration (44.4 vs 40.2), but contained less CP (12.2 vs 20.3%) and ADF (22.1 vs 32.6%) than alfalfa pellets. Replacing alfalfa pellets with kenaf pellets decreased total diet concentrations of CP, NDF, and ADF

(Table 1). The kenaf pellets used in this experiment contained 82.6% kenaf hay. The addition of molasses and mineral oil reduced the CP concentration, but they were added to improve the physical qualities of the pellets. The bulk density of the kenaf pellets was 0.513 g/cm<sup>3</sup>, which was similar to the bulk density of the alfalfa pellets (0.598 g/cm<sup>3</sup>). The kenaf hay used to make the pellets contained 13.6% CP, 53.8% NDF and 26.8% ADF. The composition of the kenaf hay was similar to that reported by Swingle et al. (1978) and Phillips et al. (1996;1999). The chemical composition of kenaf hay is greatly influenced by harvesting date (Phillips et al., 1999).

In general, fecal output ( $P = 0.02$ ) increased as BW increased. As a result, digestibility of the N ( $P = 0.01$ ), NDF ( $P = 0.02$ ) and ADF ( $P = 0.03$ ) fractions of the diet decreased as BW increased. As DM intake increased, the rate of passage and ruminal turnover rate increased proportionally (Okine and Mathison, 1991). With less resident time in the digestive tract, fiber digestion usually decreases. Body weight was not a significant factor in the model for other responses. Data are presented as dietary treatment means.

The amounts of N and ADF consumed decreased ( $P = 0.01$ ) as the amount of kenaf fed increased (Table 2). This was due to the lower concentration of these components in kenaf pellets as compared to the alfalfa pellets. However, DM digestibility was not affected until kenaf pellets had replaced about 60% of the alfalfa pellets (Diet 3; Table 2). Although the concentration of NDF in kenaf pellets was similar to that found in alfalfa pellets, NDF digestibility increased ( $P = 0.001$ ) as the concentration of kenaf in the diet increased. We concluded that the NDF in a kenaf pellet was more digestible than the NDF in an alfalfa pellet. The combination of a more digestible NDF fraction and a lower concentration of ADF in kenaf pellets should have resulted in higher DM digestibility compared to alfalfa pellets.

Replacing alfalfa pellets with kenaf pellets tended to decrease ( $P = 0.10$ ) the amount of N consumed (Table 3). Replacing alfalfa with kenaf did not ( $P = 0.34$ ) affect the amount of N retained when expressed as g/d, percent of N intake, or percent of N absorbed (Table 3). Suriyajantraton et al. (1973) compared dehydrated kenaf leaves with alfalfa meal when used as a protein supplement in sheep diets. They reported that whereas DM and CP digestibility was higher in the diet containing kenaf, N retention was lower. They concluded that the protein in kenaf was more soluble than the protein in alfalfa. Because the diets they used contained a low concentration of digestible DM, the extent of soluble dietary N utilization was limited. In contrast, the diets used in the present experiment were higher in digestible DM and would utilize a higher proportion of soluble protein. Therefore, differences in soluble protein concentration between alfalfa and kenaf pellets would not be a factor.



**Table 2.** Amount consumed (g/d) and digestibility (%) of DM, N, NDF, and ADF in lambs fed a basal diet of corn with different proportions of alfalfa and kenaf pellets

Item	Diet <sup>a</sup>			SE
	1	2	3	
Amounts consumed, g/d				
DM	829.0	873.0	884.0	20.6
N	18.3 <sup>x</sup>	17.9 <sup>xy</sup>	16.8 <sup>y</sup>	0.45
NDF	206.2	212.4	211.8	4.94
ADF	127.7 <sup>x</sup>	122.9 <sup>x</sup>	113.7 <sup>y</sup>	3.54
Digestibility, %				
DM	77.09 <sup>x</sup>	75.87 <sup>x</sup>	81.17 <sup>y</sup>	0.84
N	69.43 <sup>x</sup>	63.94 <sup>y</sup>	68.25 <sup>x</sup>	3.39
NDF	53.61 <sup>x</sup>	50.64 <sup>x</sup>	62.32 <sup>y</sup>	1.87
ADF	25.84 <sup>x</sup>	24.34 <sup>x</sup>	42.70 <sup>y</sup>	3.30

<sup>a</sup>Diet 1 = 59.5% corn and 40.5% alfalfa pellets; Diet 2 = 59.7% corn, 28.4% alfalfa pellets, and 11.9% kenaf pellets; and Diet 3 = 59.6% corn, 16.5% alfalfa pellets, and 23.95% kenaf pellets.

<sup>x,y,z</sup>Means in the same row with different letters are different,  $P < 0.05$ .

Using a value of 87% as the DM digestibility for the corn component in Diet 1, we calculated the digestibility of the alfalfa pellet to be 62.2%. This value is lower than the 68.4% calculated from data reported by Weder et al. (1999). Using the digestibility values from Diet 1 for corn and alfalfa pellets, we calculated the DM digestibility of the kenaf pellets in Diet 2 to be 51.5% and 79.2% in Diet 3. As the proportion of kenaf in the diet increased, the estimate of kenaf pellet DM digestibility increased. In previous work at this laboratory, we have evaluated kenaf fed as freshly harvested forage and as silage and reported DM digestibility ranging from 58.9 to 82.4%, depending on the date of harvest (Phillips et al., 1996). In another experiment, we looked at the in situ disappearance of the OM and N fractions of kenaf harvested at different intervals after planting (Phillips et al., 1999). At 62 d after planting, OM in situ disappearance was 73.7%, and N disappearance was 85.5%. In the present experiment, our calculated DM digestibility ranged 51.5 to 79.2%. However, these values are for a pellet that contained only 82.6% kenaf hay. The other ingredients in the kenaf pellet were molasses and mineral oil, which we would anticipate to be more digestible than kenaf hay.

### Exp. 2: Growth Trial

Fescue hay contained more CP than bermudagrass hay, but had similar concentrations of NDF and ADF (Table 4). Cool-season grasses usually contain higher concentrations of CP and lower concentrations of NDF than warm-season grasses (Galloway et al., 1991; Buxton et al., 1995). Therefore, intake and digestibility of cool-season grasses should be higher than that observed for warm season grasses. Lambs fed fescue consumed more ( $P = 0.002$ ) hay than lambs fed bermudagrass (Table 5). Goetsch and Johnson (1999) reported that lambs consumed more fescue hay than bermudagrass because fescue hay was more digestible than bermudagrass hay. Although the lambs used in their experiment were larger (BW = 52 kg) than those used in the present experiment, total DMI in grams per kilogram of metabolic BW were similar. In a trial similar to the present one, Emile et al. (2000) reported that lambs (BW = 32 kg) consumed 860 g of fescue hay in addition to 258 g of supplement.

During the first 3 wk of the experiment, hay intakes increased from 427 g/d during wk 1 to 718 g/d during wk 3. The ambient temperature peaked during wk 4

**Table 3.** Nitrogen balance in lambs fed a basal diet of corn with different proportions of alfalfa and kenaf pellets as a supplement

Item	Diet <sup>a</sup>			SE
	1	2	3	
Nitrogen				
Consumed, g/d	18.3 <sup>y</sup>	17.9 <sup>yz</sup>	16.8 <sup>z</sup>	0.45
Fecal, g/d	5.6 <sup>z</sup>	6.5 <sup>y</sup>	5.3 <sup>z</sup>	0.26
Urinary, g/d	8.8 <sup>y</sup>	6.0 <sup>z</sup>	6.9 <sup>yz</sup>	0.79
Retention, g/d	3.9	5.4	4.6	0.67
Retention, % of N intake	21.3	30.2	27.4	3.86
Retention, % of N absorbed	30.7	47.4	40.0	5.83

<sup>a</sup>Diet 1 = 59.5% corn and 40.5% alfalfa pellets; Diet 2 = 59.7% corn, 28.4% alfalfa pellets, and 11.9% kenaf pellets; and Diet 3 = 59.6% corn, 16.5% alfalfa pellets, and 23.9% kenaf pellets.

<sup>yz</sup>Means in the same row with different letters are different,  $P < 0.05$ .

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**Table 4.** Chemical composition (% of DM) of hay and supplements used in growth trial (Exp. 2)

Item	Hay		Supplement	
	Fescue	Bermudagrass	Alfalfa	Kenaf
CP	17.4	10.1	15.8	13.1
NDF	73.7	71.9	45.8	42.3
ADF	36.8	34.6	30.9	22.1

of the trial at a daily mean of 29.4°C, which was 4.4°C greater than the week before. During the next 2 wk, hay intake declined in the lambs fed bermudagrass hay, but not in those fed fescue hay. Goetsch and Johnson (1999) reported that high ambient temperatures affected DM intakes of bermudagrass hay more than fescue hay. They concluded that as the ambient temperature increases, water intake increases and rumen retention time decreases. This can reduce ruminal retention and decrease ruminal DM digestion.

The alfalfa pellets used in Exp. 2 contained less CP than the alfalfa pellets used in Exp. 1 (15.8 vs 20.3%). We selected the alfalfa pellets used in Exp. 2 to more closely match the CP level of the kenaf pellets (Table 4). The kenaf pellets still contained a lower concentration of NDF (42.3 vs 45.8%) and ADF (22.1 vs 30.9%) than the alfalfa pellets (Table 4).

There were no significant ( $P = 0.90$ ) interactions between the supplement fed and hay source. Averaged across hay source, lambs fed alfalfa pellets consumed 682 g of hay DM/d and the lambs fed kenaf pellets consumed 684 g of hay DM/d. The alfalfa and kenaf pellets were quickly consumed by the lambs shortly after feeding. In other experiments, we had observed that lambs readily consumed diets containing kenaf (Phillips et al., 1996).

One lamb fed alfalfa pellets and two lambs fed kenaf pellets were deleted from the data set due to poor DM intake (Table 6). Changes in BW over the next two 4-wk periods were not affected by the supplement fed, but were different between the hay groups. During the

first 4 wk of the trial, lambs fed the fescue hay gained almost twice as much ( $P = 0.001$ ) weight (2.40 kg vs 4.55 kg) as the lambs fed the bermudagrass hay. Weight gains during the second four-week period were less than those observed for the previous 4-wk period. The amount of weight gained over the 8-wk experimental period was greater ( $P = 0.001$ ) for lambs fed fescue hay compared to lambs fed bermudagrass hay. Emile et al. (2000) reported ADG of 110 g in ram lambs fed endophyte-free fescue and supplement. In our experiment, we observed an ADG of 120 g in lambs fed fescue hay. The higher ADG in lambs fed either hay during the first half of our experiment could be a reflection of an increase in gastrointestinal fill.

Based on observed DM intake and published values for energy density of the diets, we predicted the lambs would have an ADG of 65 g on the bermudagrass diet and 105 g on the fescue diet (NRC, 1985). Actual ADG was close to our predicted ADG. Lambs fed bermudagrass hay had ADG of 71 g and lambs fed fescue hay had ADG of 120 g. However, when we used CP intakes to predict lamb performance (NRC, 1985), actual gains greatly exceeded the predicted performance. Lambs fed the bermudagrass diets consumed 88 g of CP/d, which was less than the 103 g needed for maintenance. Lambs fed fescue diets consumed 139 g of CP/d which was 36 g above the calculated maintenance requirement of 103 g. Westendorf and Gordon (1998) used grain base diets and reported ADG of 120 g on a CP intake of 125 g/d. They also reported a positive N balance in lambs (BW = 24 kg) consuming as little as 54 g of CP/d. Gains improved when the amount of undegradable CP fed was increased without increasing CP intake. Variation in ruminal degradation of forage protein makes it difficult to predict the impact of supplemental protein on microbial growth and its influence on DMI (Greenwood et al., 2000; Mathis et al., 2000; Swanson et al., 2000).

Lambs fed fescue hay had higher ( $P = 0.001$ ) blood urea N concentrations than lambs fed bermudagrass hay (Table 7). Elevated blood urea N levels reflect increased N intakes, and have been used as an indicator of excessive protein intake. Blood urea N values similar to those observed in this experiment were reported by Westendorf and Gordon (1998) for lambs that consumed 65 to 82 g of CP/d. They concluded that higher blood urea-N concentrations could indicate an imbalance between ruminal degradable and undegrad-

**Table 5.** Weekly DMI (g/d) of fescue or bermudagrass hay (Exp. 2)

Week of experiment	Hay		SE
	Bermudagrass	Fescue	
1	392	452	35
2	513 <sup>a</sup>	653 <sup>b</sup>	52
3	700 <sup>a</sup>	735 <sup>b</sup>	44
4	613 <sup>a</sup>	732 <sup>b</sup>	39
5	604 <sup>a</sup>	852 <sup>b</sup>	38
6	744 <sup>a</sup>	813 <sup>b</sup>	51
7	737 <sup>a</sup>	864 <sup>b</sup>	30
8	664 <sup>a</sup>	844 <sup>b</sup>	48
mean	621	743	63

<sup>a,b</sup>Means in the same row with different letters differ,  $P < 0.01$ . Values do not include the supplement (185 g/d).

**Table 6.** Mean BW and changes in BW in lambs fed either fescue or bermudagrass hay with either alfalfa or kenaf supplementation

Item	Hay		SE	Supplement		SE
	Bermudagrass	Fescue		Alfalfa	Kenaf	
Number of lambs	13	16		15	14	
Initial BW, kg	30.4	30.5	0.29	30.0	30.9	0.28
Final BW, kg	34.5 <sup>a</sup>	37.2 <sup>b</sup>	0.39	35.4	36.3	0.38
Gain by period, kg						
Period 1 (d 0 to d 28)	2.40 <sup>a</sup>	4.55 <sup>b</sup>	0.34	3.84	3.31	0.32
Period 2 (d 29 to d 56)	1.63	2.17	0.36	1.66	2.21	0.35
Total gain (d 0 to d 56)	4.03 <sup>a</sup>	6.72 <sup>b</sup>	0.51	5.50	5.52	0.49

<sup>a,b</sup>Means in the same row and hay or supplement treatment with different letters differ,  $P < 0.01$ .

**Table 7.** Blood urea N concentration at the beginning (d 0), middle (d29) and end (d 57) of the experimental period in lambs fed either fescue or bermudagrass hay with either alfalfa or kenaf supplementation

Item	Hay		SE	Supplement		SE
	Bermudagrass	Fescue		Alfalfa	Kenaf	
Number of lambs	13	16		15	14	
Blood urea N, mg/dL						
d 0	12.5	12.4	1.00	13.1	11.8	1.00
d 29	10.3 <sup>a</sup>	16.1 <sup>b</sup>	1.09	13.4	13.2	1.09
d 57	10.8 <sup>a</sup>	14.5 <sup>b</sup>	0.56	12.6	12.8	0.56

<sup>a,b</sup>Means in the same row and hay or supplement treatment with different letters differ,  $P < 0.01$ .

able protein content. Although Suriyajantratong et al. (1973) reported that kenaf protein was more soluble than alfalfa protein, we did not observe any differences in blood urea N concentrations in lambs fed either alfalfa or kenaf pellets.

### Implications

Kenaf is a new crop in the United States that can be grown in most of the country. Although its primary use has been as a fiber crop, it can be harvested as hay and used as an ingredient in processed feeds to replace alfalfa hay. Lambs readily consumed pellets that contained kenaf hay, and had similar ADG to lambs fed alfalfa pellets. The NDF fraction of kenaf pellets may be more digestible than the NDF in alfalfa pellets, which would increase total diet DM digestibility. Pellets with more than 82% kenaf hay harvested 58 d after planting were successfully used to replace alfalfa pellets without decreasing intake, N balance, or performance of lambs.

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